OUR ASTRONOMICAL COLUMN.

THE TOTAL SOLAR ECLIPSE OF MAY, 1900.—The report of the expedition organised by a joint committee of the Royal Dublin Society and the Royal Irish Academy to observe the total solar eclipse of May, 1900, has just been published in vol. viii. (series ii.) of the *Scientific Transactions* of the Royal Dublin Society.

The instruments used were chiefly lent by Sir Howard Grubb and Mr. W. E. Wilson, F.R.S., who, with Prof. Joly, Dr. A. A. Rambaut and others, were members of the expedition. They included two cœlostats and two coronagraphs, one of the latter being of 4 inches aperture and 19 feet 4 inches focal length, the other of 6 inches aperture and 7 feet 10½ inches focal length; a special spectroscopic apparatus for securing a continuous series of photographs of the spectrum of the chromosphere was also taken. The second of the two coronagraphs was used with a coloured screen, made by "fixing" an ordinary unexposed film, and then soaking it in a bath of tartrazine, which allowed only the green light about the chief coronal radiation to be photographed. The resulting negative, which was exposed for eighty seconds, shows considerable extension of the outer corona, although the spectroscopic observations indicated that the green corona line was very faint during this eclipse.

The spectra were obtained with a kinematograph especially designed by Sir Howard Grubb to take twelve plates at the second and twelve at the third contact, in such a manner that no interval occurred between two successive exposures, the idea being to observe whether all the bright lines appeared or disappeared simultaneously, or whether some became reversed earlier than others as would be expected if their respective absorptions took place at different levels. It was found that the lines generally disappeared in the order of brightness shown on the original spectrum, although there were several exceptions to this rule, notably the strontium lines at λ 4078 and λ 4216, which disappeared earlier than other lines of the same original intensity. These differences are shown in the analytical table which accompanies Dr. Rambaut's discussion of the spectra. The wave-lengths and origins given in this table seem less determinate than those which have been previously published by other observers. Several plates showing reproductions of the corona photographs, which have been discussed by Mr. Wesley, and of the spectra are given at the end of the paper.

CLOUDS ON MARS.—An article by Mr. Denning, published in the December number of the *Bulletin* de la Société astronomique de France, records the appearance of cloud-like formations on Mars during the latter half of May. On May 19 and 21 the Syrtis Major was dark and sharply defined, but on the latter date a brilliant region appeared over its southern extremity, whilst on May 23 this region was very faint and ill-defined, although other features usually less obvious were plainly seen. Mr. Denning describes the region as appearing to be covered by strongly reflecting vapours which were not dense enough to hide completely the surface, but were sufficiently dense to give it a more luminous and less definite appearance. On May 25 and 27 a luminous zone was observed to the north of the Mare Cimmerium, and during the latter part of the month an extensive luminous band was visible along the northern edge of this sea, Syrtis Major, and the Linus Sabæus. It seems probable to Mr. Denning that the clouds of white vapour which were observed on the eastern edge, south of Syrtis Major, on May 21 travelled very rapidly in a northern direction, and thus caused the lack of definition observed in the above regions on the later dates, and he connects this phenomenon with the appearance of a white projection observed by Mr. Lowell, at Flagstaff, on May 26.

Several other remarkable phenomena, notably a marked division of Nilus by a bright spot, which extended far to the south-east from the eastern edge of the Lunæ Lacus, on May 4, were observed by Mr. Denning, and, on analysing his observations, he arrives at the conclusion that *real* changes do present themselves in the details of several Martian features, although many of them may be only temporary and due to atmospheric causes.

As regards the question of Martian canals, Mr. Denning states that there is no doubt as to the objective reality of the streaked and striated appearance of the northern hemisphere, and to him the canals appear not as straight and narrow lines, but as currents of dark material with frequent condensations having the appearance of a natural rather than an artificial origin.

SEISMOLOGICAL NOTES.

THE fourteenth number of the *Publications* in European languages issued by the Earthquake Investigation Committee of Japan is entirely devoted to a profusely illustrated paper on the modulus of rigidity of rocks, by Mr. S. Kusakabe. The experiments, which are a continuation of investigations made by Prof. H. Nagaoka on the elastic constants of rocks, relate entirely to torsion, and show, amongst other things, that even for very small strains Hooke's law does not hold, that in the relationship of stress to strain, or twisting couple to twist produced, rocks exhibit a marked *hysteresis*, and that the modulus of rigidity of a rock in its virgin state is greater than is usually supposed. Inferences to be drawn from these important investigations (in which stresses are applied *slowly*) are that waves of small amplitude are propagated with a higher speed than those with a large amplitude (increase an amplitude ten times and the velocity is reduced to half or one-third), also in a strained medium, as, for example, along a mountain chain, velocity is somewhat increased. In view of the first of these inferences, Mr. Kusakabe does not see the necessity to assume that the tremors of an earthquake follow paths different from that of the large waves or shocks. Whether we agree or disagree with this suggestion, we can congratulate the author on his important memoir, which is a new leaf in seismometrical research.

Amongst other recent publications relating to earthquakes we have before us Nos. 13 and 14 of the new series of *Mitteilungen* issued by the commission appointed by the Vienna Academy of Sciences for seismological investigations.

The first of these, by Dr. R. Hoernes, gives an account of the earthquake which, on July 5, 1902, resulted in considerable destruction along a line to the east of Saloniki, and fairly parallel with the Vardar River. This is a fault line along which there are hot and other springs. From the fact that these became muddy, altered in temperature and in volume, whilst new springs were created, as at Güvezne, the inference is that the earthquake was accompanied by subterranean rearrangements of strata. A discussion of the movements along this and other fault lines in Macedonia, and of changes in level which are apparently in progress at Saloniki and its neighbourhood, leads to the conclusion that hypogenic geological processes have in this part of the world a marked activity.

The second communication, from Prof. Dr. W. Láska, is on the determination of the distance of earthquake origins from observing stations by means of seismograms. That the differences in time between the arrival of various phases of earthquake motion vary with the distance an earthquake has travelled is a fact which has received application for many years. In the reports of the Seismological Investigation Committee of the British Association (1900 and 1902), by means of curves the relationship between the time intervals and distances is expressed geometrically. Dr. Láska gives similar information by means of tables. From observations made at three stations he also gives equations the solution of which leads to the determination of a latitude and longitude for an epicentrum. In the British Association report for 1900 simpler and more certain solutions are given for the same problem.

In No. 15 of the same *Publications* Dr. Eduard Mazelle gives the results of his investigations respecting the connection between microseismical pendulum movements, the wind, barometric pressure, the state of the ocean, and other natural phenomena. The results at which the author arrives confirm the results from similar analyses made many years ago in Japan, and to be found in the *Transactions* of the Seismological Society of that country and in the reports of the British Association. We are told that it is difficult to find a direct connection between tremors and atmospheric

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pressure. Tremors occur most frequently, but by no means always, with marked changes in pressure. An observation more novel in its character is that days when pendulums were much disturbed in Trieste coincided with corresponding disturbances in Strassburg. It is apparently taken for granted that the tremors recorded have a seismic origin.

In No. 16 Dr. J. Knett publishes a list of 507 shocks which were recorded between February 13 and May 6 in north-west Bohemia, which he follows in No. 18 by an account of an earthquake which on November 26, 1902, disturbed the same country.

No. 17, by Adolf Faidiga, is a lengthy description of the earthquake which, on July 2, 1898, created considerable destruction on the coast of Dalmatia, the vibrations from which reached Great Britain. It is largely of local interest.

In Nos. 2 and 3 of vol. ix. of the *Bolletino Della Società Sismologica Italiana,* the well-known earthquake register published by this body is brought up to March 5, 1902. This is supplemented by two papers. In No. 2 Dr. A. Ricco adds to the knowledge we possess respecting the crater of Etna, and changes which are taking place in the same. On August 23, 1900, the interior of the crater was described and photographed. Its depth was then 282 m. On July 21, 1903, it was again photographed, and its depth was found to be 490 m. The supplementary contribution to No. 3, by S. Costanzo, is on the relationship or want of relationship between the wind and tromometric movements. The author apparently holds with Bertelli and others that the pendulum movements have an endogenous origin, and are not produced by the wind, but that they accompany, precede, or follow falls in barometric pressure. Dr. Agamennone regards the movements in question as being in great measure influenced by the wind. Our own experience, which is detailed in the *Transactions* of the Seismological Society of Japan, reports to the British Association, and in other works, is that vertical or horizontal pendulums, chemical balances, and like apparatus are set in movement when there is a marked fall in barometric pressure, a steep barometric gradient, or a marked fall in temperature; the movements more frequently occur during the night and in winter than during the day and in summer, and they may or may not occur with heavy gales. Instruments in a close atmosphere, as, for example, in a cellar, are more likely to be disturbed than similar installations in a well ventilated or even draughty room. Burning a lamp or a gas jet in a room frequently brings so-called microseismic storms to an end, and what occurs and creates annoyance in one room may not be observed in a neighbouring apartment.

In vol. ii. of the reports of the Mathematical-Physical Society of Tokio, amongst forty-seven papers which for the most part are mathematical we find five by Dr. F. Ōmori and one by Mr. A. Imamura which relate to seismology. The former of these contributions may, to a large extent, be regarded as epitomised reproductions of papers previously published by the Tokio Earthquake Investigation Committee, which we have already noticed (NATURE, April 30, July 9, 1903). In a note on the seismograms of distant earthquakes, Dr. Ōmori tells us that the "motion consists of a series of different epochs, in each of which the period remains essentially constant, while the amplitude, on the whole, is also constant, except for the occurrence of maximum and minimum groups." In a table we find ten groups, in which the periods vary between 1·02 and 66 second. After discussing the amplitudes and durations of these various phases, it is shown that the arcual velocities vary between 2 and 11·3 km. per second; as the result of more accurate work, this last quantity is now raised to 14·1 km. per second. One argument in favour of the supposition that the preliminary tremors and other phases of earthquake motion follow arcual paths is that the durations of these successive phases are proportional to the arcual distances they have travelled, and these durations are approximately equal to each other. The speeds for certain earthquakes were determined by dividing the difference of the distances of Tokio and certain European stations from an origin by the difference of the times of the arrival of seismic waves in Tokio and Europe. This, it must be observed, involves the idea that the velocity of preliminary tremors on short paths or on long paths is equal. Lastly, it is assumed that each phase recorded at a distant station originated simultaneously at the earthquake origin.

The results to which we are led by assumptions of this nature are well illustrated in the paper, "Notes on Milne Horizontal Pendulum Seismograms," by Mr. A. Imamura. In this paper records of the Guatemala earthquake of April 19, 1902, as published in circular No. 6 by the Seismological Investigation Committee of the British Association, are analysed. One result is to show that the preliminary tremors had an arcual velocity of 15·6, whilst the eighth phase of motion had only a velocity of 2·1 km. per second. These determinations, amongst other things, depend upon the time at which this earthquake originated, which Mr. Rockstroh, in Guatemala, gives as 2·27 a.m. G.M.T. This, it must be observed, apparently depends upon a single observation made at some distance from the epicentre. As being more probably correct, Mr. Imamura adopts 2.26 a.m. as the time of origin. Curiously enough, the determination of the exact time at which this particular disturbance took place became a matter to be considered by the law. At or about the time of the earthquake a certain block of buildings insured against fire, but not, as was stipulated in the policy, against fire occasioned by an earthquake, was burned down. The owners of the block claimed that the destruction was occasioned by the overturning of a lamp immediately before the earthquake, and if this were the case, the loss naturally fell upon the insurance company. The result was that a careful inquiry was instituted to determine the time when Quezaltenango and other cities were wrecked, and, so far as the writer knows, the time given for this occurrence was 2h. 21m. or 2h. 22m., which is a time that falls in line with what we know of earthquake speeds, and the times at which this earthquake was recorded at stations cooperating with the British Association in North America and round the Atlantic. If this latter time is fairly correct, and we therefore add 4 or 5 minutes to the time ordinates given by Mr. Imamura, we see that the times for transit of the first phase of earthquake motion are *not* proportional to arcual distances. The speed over short paths is less than it is over long paths. When we look at phase 8, which occurs about twenty minutes after the maximum, and see the many phases which follow, we do not see the reason why the transit velocity of phase 9, or even of phase 20, should not have been considered.

Following the maximum, as an earthquake dies there is almost invariably a series of fairly rhythmical impulses which gradually grow less in amplitude. These are separated by intervals of from two to five minutes, and may extend over two or three hours. Inasmuch as these phenomena may be observed equally well near to an earthquake origin as at a distance from the same, it would be unreasonable to suppose that if we were at a short distance from a centrum the movements last recorded there had been two or three hours longer on their journey than those first recorded. In rocky materials waves of small amplitude may travel more quickly than those of larger amplitudes; in an earthquake there may be ripples due to surface tension together with the more pronounced compressional, distortional, and gravitational waves, all of which may originate at practically the same time, but if we consider this to be the case for the followers of the main portion of a seismic disturbance, we are led to conclusions apparently unacceptable. The fairly uniform time spacing between the expiring efforts of an earthquake as recorded at a distance from an origin or near to the same, rather than leading to the conclusion that paths are arcual, suggests a rhythmical series of surgings possibly due to interferences or reflections at or near a centrum. A collapse takes place and a mass is launched upon some substratum. Each has its natural period, and when these coincide, it seems possible that at approximately equally spaced intervals a more vigorous set of waves starts out and adds to the train of its predecessors.

The first response to the primary disturbance may be the well-known *Uri Kaishi*, or return shaking, whilst its followers, which die down rapidly in amplitude, like the swinging of a damped pendulum, resemble a family series, children with children's children decreasing in vigour, not born simultaneously, but successively.

The general criticisms on the behaviour of the Milne horizontal pendulum are made without any reference to the

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object for which it was installed, which was to determine "the times at which various phases of motion are recorded" (see British Association Reports, 1897, p. 130. Copy of a circular sent to foreign Governments and colonies). This it does, and a little more. If an observer desires to have an open diagram, he must employ clockwork to drive the record receiving surface at a higher speed, whilst a longer period than the one usually employed can be obtained by adjustment. It must, however, be remembered that the period obtained at one station may, on account of the wandering of the pendulum and "tremors," be unpractical at another, and that difference in adjustment at different stations destroys uniformity. Although with the object of stimulating further research we have criticised certain portions of the work before us, the bulk of it commands the admiration and thanks of all seismologists.

THE GILBERT TERCENTENARY.

THE tenth of this month was the three hundredth anniversary of the death of Dr. William Gilbert, the celebrated Elizabethan philosopher who laid the foundations of the science of electricity. The occasion was celebrated on Thursday, December 10, at the meeting of the Institution of Electrical Engineers by the presentation of a picture by the Institution to the town of Colchester, in which place Gilbert was born and died. The picture was painted by Mr. Ackland Hood; it is a fine historical painting representing Dr. Gilbert showing his electrical experiments to Queen Elizabeth.

The proceedings were opened by the president of the Institution with a short speech. Prof. S. P. Thompson then gave a brief address, in which he outlined Gilbert's life and his contributions to science. Gilbert was born in Colchester in 1544, and was educated at the school there and subsequently at St. John's College, Cambridge, at which he became mathematical examiner and senior bursar. He took the degree of M.D. in 1569, and rapidly advanced in the profession, becoming in 1599 president of the Royal College of Physicians, and a year later physician to the Queen. He died at Colchester on December 10, 1603, and was buried there in the Church of Holy Trinity. Eminent as he was as a physician, his claim to immortality rests not on his work in medicine, but on his pioneering investigation in the then almost non-existing sciences of magnetism and electricity. To him we owe the science of terrestrial magnetism; by numerous and careful experiments upon the loadstone he discovered many of the most important principles of magnetism, such as the existence of a magnetic field—an "orbe of virtue"—around the magnet, the screening effect of iron, and the destroying effect of heat. From experiments on a globular loadstone he was able to evolve the theory that the earth is itself a great magnet. Thus many years before Bacon, who is usually regarded as the father of the inductive method, Gilbert was using this method with signal success.

Gilbert's contributions to electricity are contained in the second chapter of Book ii. of the celebrated "De Magnete." He showed that not amber alone, but many other bodies, which he put in a class called *electrics*, can attract solid bodies when rubbed; that they attract everything, not merely straws or chaff; that damp weather hinders the electrification; and that a flame destroys it, as well as many other important facts which are now the fundamental principles of the science. He invented the electroscope, and discovered that the force of attraction is in a straight line towards the electrified body. From these simple beginnings has been gradually evolved in 300 years the immense structure of pure and applied electricity.

The Mayor of Colchester thanked the Institution for its gift in a brief and humorous speech. Amongst many other distinguished men present at the meeting were Sir W. Huggins, president of the Royal Society; Sir Dyce Duckworth, treasurer of the Royal College of Physicians, an office twice held by Dr. Gilbert; Prof. J. Larmor, representing St. John's College, Cambridge; the Mayor of Westminster; and Mr. Ackland Hood, the painter of the picture.

AGRICULTURAL NOTES.

THE third report on the Woburn Experimental Fruit Farm, recently issued by the Duke of Bedford and Mr. Spencer Pickering, F.R.S., is devoted to a discussion of the effects of grass on apple trees. In previous reports it was shown that grasses prove most injurious to young apple trees, and the experiments described here were designed to throw light on the causes of injury. Up to the present time the cause, or causes, have not been discovered, but the experimenters have made considerable progress, for they have shown that their first suspicions were unfounded. Grasses might reasonably be expected to injure young fruit trees by interfering with their air, or water, or food supply, but the careful experiments recorded in the report indicate that interference with air, water, and food has little or nothing to do with the question, and that the injury "must, in all probability, be attributed to the action of some product, direct or indirect, of grass growth which exercises an actively poisonous effect on the roots of the tree." This conclusion is based partly on the negative evidence of the experiments, in which the supplies of food, air, and water were controlled, and partly on the appearance of the trees grown in grass. These trees were always very sharply marked off from the others by peculiar tints of leaf and fruit, quite unlike those due to starvation, and produced obviously by some unhealthy condition of soil. The effects of grass on apple trees have been studied only on the shallow clay soil of the Woburn Fruit Farm and on a clay soil at Harpenden, and it is possible, as the experimenters are careful to point out, that on a richer soil, and in a different climate, grass might not prove injurious, but the Woburn experiments clearly indicate that horticulturists should avoid planting apples in grass, unless there is local evidence that grass does not injure the young trees.

In their work on apple trees the Duke of Bedford and Mr. Pickering are dealing with a special and well-marked case of a general problem of great interest to agriculturists—the effects of crops and of crop residues on the quality of soil. Every observant cultivator knows that land may get "sick" or "over-cropped" when a plant is grown too often, and he also finds that certain plants "exhaust" the soil in a peculiar degree for certain other plants. He has been told that this is a "food" or a "special food" question, and that interference with the air, food, and water supply explains all the ills which plants may suffer from competition with their fellows. At the same time, he does not feel satisfied that such phenomena as the disappearance of clover from land, or the effects of rye-grass on wheat are due to straightforward competition, and the "poison" theory of the Woburn experimenters will arrest his attention. Seventy years ago agriculturists were discussing De Candolle's "excretory theory," and found in it the chief explanation of the benefits due to a rotation of crops; when the theory was abandoned the facts from which it originated were forgotten, and in connection with the effects of grass roots on apple trees the following sentence from De Candolle is worth recalling:—"Thus we know that the thistle is injurious to oats, the Euphorbia and Scabiosa to flax, the *Inula betulina* to the carrot, the *Erigeron acre* and tares to wheat, &c." Though the plant does not "excrete," it may readily influence the character and condition of the soil either directly by the decomposition of its roots, or indirectly through its effect on soil organisms, and the Woburn experiments, which deal with this subject, will be closely followed.

In a paper entitled "Recherches sur la Synthèse des Substances Albuminoïdes par les Végétaux," MM. Laurent and Marchal, of the State Agricultural Institute, Gembloux, give a useful *résumé* of the sources of nitrogen to plants. In doing so they point out that during the latter half of the nineteenth century there was a tendency to overlook the importance of ammoniacal compounds, and to regard nitrates as the only sources of nitrogen to the higher plants. While nitrates are of chief importance, there are many plants, even colonies of plants, such as forest trees and the vegetation of marshes, that must depend largely or entirely on compounds of ammonia for the supply of nitrogen. The authors describe experiments on cress, white mustard, chicory, asparagus, white melilot, Persian lilac, and tobacco, and among other conclusions state that sun-

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